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(54) **Water filtration device**

(57) The invention relates to a water filtration device for purifying and at least to some extent reducing the hardness of raw water, said device being comprised of a raw water supply means (15) and a raw water withdrawal means (12), and distribution means (27) for dividing the water supplied through the supply means (15) [lit., "(27)"] into two partial streams. In order to provide such a device and an associated method, whereby the water withdrawn from the device is not completely decarbonized but is free of all other undesired substances, it is proposed according to the invention that each partial stream be passed through a respective filtration path (A, B), wherewith said paths (A, B) mutually differ at least in part.

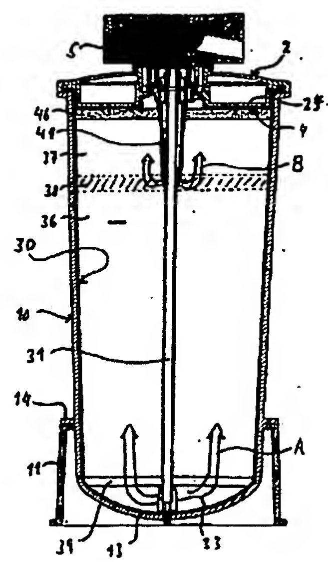

Fig.1

Specification:

(0001) The invention relates to a water filtration device for purifying and at least to some extent reducing the hardness of raw water, said device being comprised of a raw water supply means and a raw water withdrawal means, and distribution means (27) for dividing the water supplied through the supply means into two partial streams. According to the associated method, raw water is introduced to a water filtration device which has a fitting in which the water is divided into two partial streams one of which is passed through filter material and is then combined with the second partial stream and the combined flow is withdrawn via the purified water outlet.

(0002) Devices and methods of this general type have been known for some time. A principal purpose of branching off a partial stream from the raw water and subsequently recombining it with filtered water is that if the device contains ion exchange resins the water passing through such resins will essentially have all of its hardness removed, which includes complete decarbonization. For many applications this result may not be desirable. The preparation of many foods and beverages is improved if 100% de-hardened (soft) water is employed, particularly if the ingredients already contain the ions which one seeks to remove from the added water; it is also true, however, that for other foods and beverages it is desirable to use water which is not 100% de-hardened. Generally it is not practicable to solve this problem by interrupting the filtration when the desired softness is achieved; therefore the practice has been to divide the raw water to be treated into two portions, one of which undergoes full filtration and the second of which does not but is rather withheld and later combined with the first portion after said first portion has been withdrawn from the filter. Thus the combined stream comprises a mixture of fully de-hardened and un-dehardened water, with the degree of hardness adjusted by adjusting the mixture ratio.

(0003) A drawback of this technique of only partial filtration (mixing some raw water with some filtered water) is that the raw water in the branched-off partial stream likely contains other undesirable ions and impurities, in addition to carbon, and these are re-inserted into the combined stream when the branched-off stream is combined with the filtered stream. The impurities may comprise organic substances which cause an off-taste, or toxic substances or disease-causing microorganisms, the removal of which is imperative.

(0004) Against this background of the state of the art, the underlying problem of the present invention was to devise a device and an associated method, of the type described initially supra, whereby the water withdrawn from the filtration device is not fully decarbonized but is freed of all other undesirable substances.

(0005) The underlying problem relating to the method is solved [according to the invention] in that the two partial streams are at least to some extent passed through different filtration paths. One of these paths may essentially correspond to customary filtration, comprising filtration and appreciable decarbonization (of drinking water), and the other path may comprise a different filter material which does not perform decarbonization but which removes other undesirable materials from the water. The two differently filtered partial streams are then combined and withdrawn as filtered purified water which has the exact desired hardness and has a reduced content of microorganisms and essentially zero content of organic materials which adversely affect taste (e.g. chlorinated compounds) as well as chlorine, and of toxic substances such as, e.g., trihalomethyl compounds.

(0006) The underlying problem relating to the device is solved in that each partial stream is passed through a respective filtration path (A, B), wherewith said paths (A, B) mutually differ at least in part.

(0007) For purposes of description and illustration of the present invention and preferred embodiments, reference is made to three other patent Applications being concurrently filed by the present Applicant, which bear on their cover pages the internal designations NE-70, NE-71, and NE-73. It is intended that the present Application be supplemented by the matter of said other Applications, to the extent that particular features are not explicitly described herein.

(0008) Additional advantages and features will be apparent from the dependent claims, only some of which are described or discussed in this Specification.

(0009) As mentioned, preferably the two partial streams not only travel through different filtration paths but indeed through (at least to some extent) different filter materials. In principle a variant is possible in which the partial streams are passed through identical filter materials but the path of one stream through the filter material is substantially shorter than the corresponding path of the other stream, such that it is essentially impossible for complete decarbonization to occur in the shorter filtration path.

(0010) Preferably, however, the two different filtration paths comprise filter materials which are at least to some extent mutually different. Advantageously, a connecting means

or mixing means is provided, for combining the two partial streams; the design of said means should be such as to achieve maximal intermixing of the streams.

(0011) It is particularly preferred if the connecting/mixing means is provided ahead of a filtration path through which both partial streams are to be passed. Advantageously this is [essentially] the final segment of all the filtration paths. In the preferred embodiment of the invention, the filter material in this final segment comprises only activated carbon or a similar filter material, e.g. activated carbon blocks or segments, microfilters, or membrane filters. The second filtration path may comprise the described path with activated carbon but will also comprise a path segment or segments having another filter material (or materials), e.g. an ion exchange resin.

(0012) According to another embodiment, a first partial stream is passed through an outer ring-shaped region which comprises most of the cross section of the container, said passage being from the cover toward the bottom of the container, through two different filter materials (preferably an ion exchange resin and activated carbon) sequentially, and the second partial stream is passed through a ring-shaped central space which is concentric with the outer partial stream, said passage being from the cover to the bottom region [of the container], where said second stream passes through an activated carbon filter; and the two partial streams are combined in the bottom region of the container, and are [then] passed upward through a central upflow tube from the bottom to the cover.

(0013) Advantageously, the ratio of the flows in the partial streams is adjustable via a valve.

(0014) A measurement device is provided, to measure the total flow, and the flows of the partial streams (and the ratios of said partial stream flows as distributed), of the water passing through the filtration device.

(0015) It is also advantageous if a main stream of the raw water is passed through a central conduit of the filtration device, and the branched stream is passed directly concentrically around the main stream. The purified water may then be returned through a channel which is concentric with and surrounds the ring-shaped channel through which said branched stream is passed.

(0016) In a particularly preferred embodiment, the filter material is accommodated in a generally cylindrical or conical or other rotationally symmetrical space, wherewith two different layers of filter material are provided which are disposed in an essentially cylindrical or conical or other generally rotationally symmetric space. With this configuration, it is possible, e.g., to pass the raw water, through a central tube, to a region below the lower layer of filter material, and then distribute it over the cross section of the container, where it is forced upward through said lower layer by the force of the raw water itself. The partial stream is passed through a second tube disposed concentrically to the [tube bearing the] inner, main stream, which second tube is substantially shorter than the inner tube such that it terminates at an appreciable altitude above the bottom of the container, and at its lower end said second tube has exit openings for the partial stream which it bears; thus this branched partial stream ends [its downward flow] preferably in a region above the lower filter material layer and immediately below the upper filter material layer.

(0017) The two layers may be separated by a layer which has good water permeability and is preferably elastically yielding. If the branched partial stream is passed out into this layer, said stream is distributed in this region over the cross section of the container and becomes thoroughly mixed with the main stream which is flowing upward from the lower filter layer. Then the combined stream (comprising main stream and branched partial stream) flows upward through the remaining filter segment comprising the upper layer of filter material. According to a particularly preferred embodiment of the invention, this upper layer is comprised of activated carbon or a similar adsorbent material (other candidates being, e.g., zeolite, block activated carbon, or a membrane filter), whereas the lower layer of the filter material is comprised of, e.g., an ion exchange material. Thus the main stream of the water undergoes reduction in hardness in the ion exchange material, and then undergoes elimination of organic components and other toxics, and reduction of microorganisms, in the activated carbon layer; whereas the partial stream does not undergo hardness reduction (because not passed through the lower layer) but does undergo the effects of the activated carbon layer. The result [(after combining the two streams)] is a purified water with low microorganism content and no objectionable off-taste, and with a residual hardness which can be regulated by adjusting the ratio of the main stream to the partial stream.

(0018) The ratio of the main stream to the partial stream (branch stream) is adjustable at will by adjusting the amount of branching of the partial stream from the original raw water feed via the branching valve. The branched stream may in fact have a larger flow than the so-called "main stream", rendering the chosen terms "main stream" and "partial stream" misleading, but typically this will not be the case.

(0019) In accordance with the preceding discussion, the inventive method proposes that the raw water be divided into a main stream and a partial stream, with the main stream being passed through a first filtration path and the partial stream being passed through a second filtration path; wherewith in a preferred embodiment both the main stream and partial stream are passed through the second filtration path, following passage of the main stream through another filtration path, such that considered overall the two streams are passed through different overall filtration paths. Prior to passage through the second filtration path,

the two streams are recombined. In principle it would also be possible to pass the partial stream through yet another filter material prior to recombining it with the main stream, which material [(a third filter material)] might be disposed in [the annular space provided by] an appropriately widened concentric tube which surrounds the inner tube.

(0020) According to another advantageous embodiment of the inventive method, the total amount of water passing through the filter(s), the amounts of the two streams, and the ratio between the partial stream and main stream, are measured. This requires only measurement of the partial stream and main stream, or of the return stream and main stream, or of the return stream and the branched partial stream, because the return stream is essentially the sum of the main stream and branched stream. It is preferred to measure the return stream and branched partial stream, with the main stream being calculated as the difference between these. In an instance where the partial stream flow is relatively small, this method provides a more precise ratio of the partial stream and main stream, thereby enabling more exact adjustment of the valve for distribution of the streams based on the measurement results.

(0021) Clearly it is possible in principle to orient the inventive water filtration device in any desired orientation, in which case the terms "upward", "top", "downward", and "bottom" need to be understood to have the correspondingly amended meanings (e.g. the opposite meanings, or "rightward" and "leftward", etc.); the functional principles of the device and method are not changed thereby.

(0022) Additional advantages, features, and application possibilities of the invention will be apparent from the following description of preferred embodiments, with reference to the accompanying drawings.

Fig. 1 is an axial longitudinal cross sectional view of an inventive water filtration device;

Fig. 2 is a detail view of Fig. 1, showing the upper, distributor region;

Fig. 3 is a horizontal cross section through the measuring device 5 (visible in Fig. 1); and

Fig. 4 is an alternative embodiment of an outer container, with the inner container and cover in place.

(0023) Fig. 1 shows a pressurized container 10 with an inner lining or inner container 30, with a filter material 36 disposed in the lower region [of the container space] and another filter material 37 disposed in the upper region, the two filter materials being separated by a porous and preferably elastic layer 38. Filter material 36 is delimited on its lower side by a water-permeable retaining plate 39 which is disposed above a "distribution space" in which the water incoming through the central tube 31 in a "main stream" becomes distributed. The distribution space may itself be filled with filter material, which may render the retaining plate 39 unnecessary. The pressurized container 10 has a bottom 13, and a flange 14 by which the container rests on a supporting base 11. The tube [31] is supported on the bottom 13 (or on the inner lining or inner container 30) by means of distributor elements 33, which serve to provide uniform distribution of the main flow below the retaining plate 39. Other details of the pressurized container 10, the inner lining or inner container 30, and the configurations of the covers (2, 4) of the two containers, may be obtained from a second Application being concurrently filed by the present Applicant.

(0024) Fig. 2 is an enlarged cross sectional view of an upper region of the device of Fig. 1. Not shown here is the porous elastic separating layer 38 which is disposed precisely at the altitude of the slit-shaped exit openings 48 which are provided at the lower end of a tube 41 which is tapered with progression downward and which concentrically surrounds the main tube 31. An upper "fitting" 5 is provided which has an integrated measuring device and has connecting elements (7', 8', 9', 51) for engaging corresponding parts of a cover 2 of the pressurized container 10 in order to achieve a reliable and well-sealed connection of a plurality of flow channels. A central tubular fitting element 7' is sealingly connected to the tube 31 and/or to transition pieces of an interposed [inner] cover 4 so that the central channel 7 of the fitting 5 is in fluid communication with the channel 35 of the central tube 31. By means of a second tubular fitting element 8' which circularly surrounds the central tubular fitting element 7', an annular channel 8 is formed in the fitting [5], which channel is in fluid communication with the annular channel 45 via the intermediary of the intermediate [i.e. inner] cap 4; the channel 45 being formed by the tubular element 41 disposed concentrically around the tube 31, which element 41 is tapered conically with progression downward and the lower end of which is essentially sealingly disposed around [and against] the said main tube 31. The abovementioned slit-shaped exit openings 48 are disposed in said tubular element 41, in particular said openings are disposed precisely at the altitude of the water-permeable elastic separating layer 38 between the lower filter material 36 and the upper filter material 37. The upper filter material has disposed over it a separating and retaining layer 46 which serves in particular to retain filter material and other suspended particles which might [still] be present in the water, which retaining layer 46 is

water-permeable and provides a [fluid] connection to a ring-shaped space [47] in the [inner] cover 4 which space surrounds the upper end of the tubular element 41 and which is in fluid communication with the ring-shaped space 9 via openings which are not visible in this particular cross sectional view (viz. are not present in this cross sectional plane). The space 9 is formed by the tubular fitting element 9' of the fitting 5, which fitting element 9' surrounds the abovementioned fitting element 8'.

(0025) The above-described central channel 7 and ring-shaped channels (8, 9), and the corresponding tubular fitting elements (7', 8', 9'), may be seen in the plan view of Fig. 3, albeit below the plane of the cross section, which cross section is a cross section through the fitting 5 (which fitting 5 is illustrated only schematically in Figs. 1 and 2) which contains an integrated measuring device. Two threaded nipples (12, 15) may be seen on the left in Fig. 3, which nipples connect with corresponding pressurized water lines ("connections") via sealing means and union nuts; in particular, nipple 15 is connected to the pressurized water supply line and nipple 12 is connected to the pressurized water withdrawal line.

(0026) A valve 27 is disposed immediately downstream of the pressurized water nipple 15, which valve is adjustable from the exterior by means of a small hand wheel or the like; by means of this valve, the raw water flowing in through the nipple 15 is distributed to the main flow channel 26 and the partial stream channel 25; the ratio of this distribution may be selected at any value, in principle; however, preferably the engineering design of the fitting [5] is such that most of the raw water flows through the main channel 26. This main channel 26 is directly connected to the central channel 7 (which was described in connection with Fig. 2). Channel 7 is shown only in dashed lines in Fig. 3; it is formed with the aid of the tubular fitting element 7' (which is disposed behind the plane of Fig. 3).

(0027) The partial stream is split off in the partial stream channel 25 and passes first through a flowmeter 16 in the form of a "bucket wheel" or vane wheel. From there the partial stream passes into a feed channel 18 which is in fluid communication with the ring-shaped channel 8 (the ring-shaped space between the two tubular fitting elements 7' and 8') ([the boundaries of which space are] also shown in dashed lines in Fig. 3). The tubular fitting element 8' is concentrically surrounded by another tubular fitting element 9' which forms an outer boundary of the ring-shaped channel 9 which axially undergoes a transition to a channel 19 which is connected to the water outlet 12 via a second flowmeter 17 in the form of a bucket wheel.

(0028) With this arrangement, the bucket wheel 17 serves to measure all of the water which flows through the filtration device, whereas the bucket wheel (or vane wheel) 16 serves to measure only the flow (partial flow stream) through the channel 25; thus the flow through the main channel 26 is the difference between the flow of the returning filtered water and the flow in the split-off partial stream.

(0029) The number of rotations of the bucket wheels in the flow meters (16, 17) is proportional to the amount of water passed, and preferably is converted to electrical signals by corresponding transducers and is electronically recorded with the aid of an electronic measuring device, which device is also the subject of a third Application being concurrently filed by the present Applicant.

(0030) Fig. 4 illustrates an alternate embodiment of the invention. Here as well, an inner container 30" is closely fitted in a slightly tapered frustoconical outer container 10" which has walls which are sufficiently pressure-resistant. The material of the inner container 30" may be thinner and less robust, but nonetheless should have a certain shape stability when not under pressure.

(0031) The embodiment according to Fig. 4 differs from the embodiments described hereinabove in that it has a very large bottom opening which occupies nearly the entire cross section in the lower region of the outer container 10", wherewith a bottom fitting 11" is closely fitted into said bottom opening. Said opening is circular, and its inner diameter corresponds to the outer diameter of a cylindrical foot part 51 of the bottom fitting 11", which fitting 11" widens stepwise into a collar member 52 which has an outer diameter which matches the inner diameter of the lower region of the outer container 10", wherewith the lower fitting 11" and the outer container 10" together form a [major] hollow space which is sealingly closed at the bottom with no gaps, into which hollow space the inner container 30" can be inserted. The bottom, i.e. the upper surface of the bottom fitting 11", has a slightly concave configuration when regarded from above [lit., "from the container 10""]. This embodiment also has a few other features by which it differs from the embodiments described above. The cover [(4")] is essentially ring-shaped, with a box-shaped [vertical] cross section, and is generally similar to the cover of the above-described embodiments. However, the container does not have a flange edge [(24)], but rather closure elements in the form of a bayonet closure (shown only schematically) are provided on the upper edge region of the container and on the outer edge region of the cover 4". A fitting 5" is provided in the inner opening of the cover 4"; pressurized water is introduced from above into the filter chambers (II, IIa) through said fitting 5". In this connection, a branching valve is provided in the head of the fitting 5", whereby a part of the water is passed downward through a central outer tube (downflow tube) 60 which concentrically surrounds an inner tube (upflow tube) 61.

Another part of the water is passed through the branching valve to an upper distribution plate 62 which acts on the water sent to it so as to distribute said water essentially over the entire cross section of the container. An ion exchange resin or the like 59 is disposed in filter space I, and activated carbon or the like is disposed in filter spaces II and IIa. It goes without saying that other filtration materials may be used. The part of the water which flows through the outer, downflow tube 60 is passed only through filter space II, in which activated carbon is disposed, and then passes from below through a sieve plate to the inlet opening of the central, upflow tube 61. The part of the water which is passed through the filter space I and the ion exchange resin 59 passes through a perforated upper plate into filter space IIa, and exits through a sieve plate at the lower side of filter space IIa, is mixed with the water exiting from filter space I, and upwardly through the upflow tube 61. As mentioned, filter materials 57 and 58 comprise activated carbon; thus, a part of the water, namely that passed only through filter space II, has been filtered only through activated carbon, which will tend to remove microorganisms, whereas the other part of the water, which has passed through filter spaces I and IIa, has undergone a reduction in hardness as well as in microorganisms.

(0032) Packings 38" comprised of nonwoven fiber material (batting or the like) are disposed in the upper region of filter space I, where they perform a compensation function [(– i.e. to ensure that the practically usable filter material space is filled with filter material)]. Corresponding packings (55, 56) may also be disposed in filter spaces II and IIa, respectively. The packing material 38" is preferably elastically yielding, so as to be able to compensate for changes in volume of the filter material 59 disposed in filter space I; such changes may well occur in ion exchange resins which are initially dry and are wetted for the first time.

<u>Patent claims</u>:

1. A water filtration device for purifying and at least to some extent reducing the hardness of raw water, said device being comprised of a raw water supply means (15) and a raw water withdrawal means (12), and distribution means (27) for dividing the water supplied through the supply means (15) [lit., "(27)"] into two partial streams; characterized in that each partial stream is passed through a respective filtration path (A, B), wherewith said paths (A, B) mutually differ at least in part.

2. A water filtration device according to claim 1; characterized in that the filter media (36, 37) are at least partly different along the different filtration paths (A, B).

3. A water filtration device according to claim 1 or 2; characterized in that a connecting means (38) is provided, for combining the two partial streams.

4. A water filtration device according to claim 3; characterized in that the connecting means (38) is disposed immediately upstream of one of the filtration paths (A, B).

5. A water filtration device according to one of claims 1-4; characterized in that both filtration paths have a common end region (B).

6. A water filtration device according to claim 5; characterized in that the filter material disposed in the end region is essentially comprised of only activated carbon or a similar filter material, e.g. an activated carbon block or segment, or a membrane end filter.

7. A water filtration device according to claim 6; characterized in that the filtration path of the second partial stream comprises:

– an ion exchange resin and
– activated carbon or a membrane end filter.

8. A water filtration device according to one of claims 1-7; characterized in that the ratio of the flows in the partial streams is adjustable via a valve (27).

9. A water filtration device according to one of claims 1-8; characterized in that a measurement device (16, 17) is provided, to measure the total flow, and the flows of the partial streams, of the water passing through the device.

10. A water filtration device according to one of claims 1-9; wherein one of the partial streams is a main stream which is passed through most of the cross section of the container from the cover to the bottom of the filter wherewith it passes through two different filter materials sequentially, and the second partial stream is passed through a ring-shaped central space which is concentric with the outer partial stream [(said outer partial stream being said main stream)], wherewith said second stream passes only through one of the filter materials; and a return stream is provided which passes through a central upflow tube from the bottom to the top of the container; and further the two partial streams are combined downstream of the filtration paths, in the bottom region of the container.

11. A water filtration device according to one of claims 1-9; wherein one of the partial streams is a main stream which is passed centrally into the filtration device; and the second partial stream is passed immediately concentrically around the main stream; and further the return stream passes concentrically with and radially outward of the partial stream.

12. A water filtration device according to one of claims 1-10; characterized in that the filter materials (36, 37), which may be different, are disposed in distinct separated layers one above the other, wherewith the main stream is passed through both layers and a partial stream is passed through only one of the layers.

13. A water filtration device according to claim 11 or 12; characterized in that the main stream (7) passes in a central tube into a lower distribution space of a filter container, and a partial stream is passed through a second tube which is concentric with the first tube; and in that openings are provided in said second tube in the boundary region between a lower and an upper filter layer at which region [(and through which openings)] the second tube opens out; and further in that the second filtration path leads essentially only through the upper filter layer.

14. A method of purifying, and at least partially reducing the hardness of, raw water, by passing the raw water into a filtration device and withdrawing purified and filtered water from said device, wherein according to the method the raw water is divided into two partial streams which are re-combined prior to leaving the filtration device; characterized in that the two partial streams are at least to some extent passed through different filtration paths (A, B).

15. A method according to claim 14; characterized in that a first partial stream is passed centrally in the interior of a container filled with filter material, namely said stream is passed [from an upper region] to the bottom of said container where it is distributed into a collecting space and upward into a filter layer which surrounds the central tube.

16. A method according to claim 15; characterized in that the filter layer surrounding the tube is comprised of two different filter layers disposed one above the other and separated by a mixing space.

17. A method according to claim 16; characterized in that the second partial stream is passed through a second tube which is concentric with the first tube but which ends in the region of the separating layer between the two filter layers, which second tube has openings in said region.

18. A method according to one of claims 14-17; characterized in that the total amount of filtered water, and the relative distribution between the two partial streams, are measured and the measurements can be displayed to the user of the device upon demand.

19. A method according to claim 14 or one of claims 16-18, but distinctly not according to claim 15; characterized in that a first partial stream is passed in the direction from the cover to the bottom of the container, into an outer, ring-shaped area which encompasses most of the cross section of said container, and a second partial stream is passed through an inner ring-shaped space, from the cover to the bottom region of the container, and in said bottom region is passed through an activated carbon filter, wherewith the two partial streams are combined in the bottom region of the container and are passed upward to the cover via a central upflow tube.

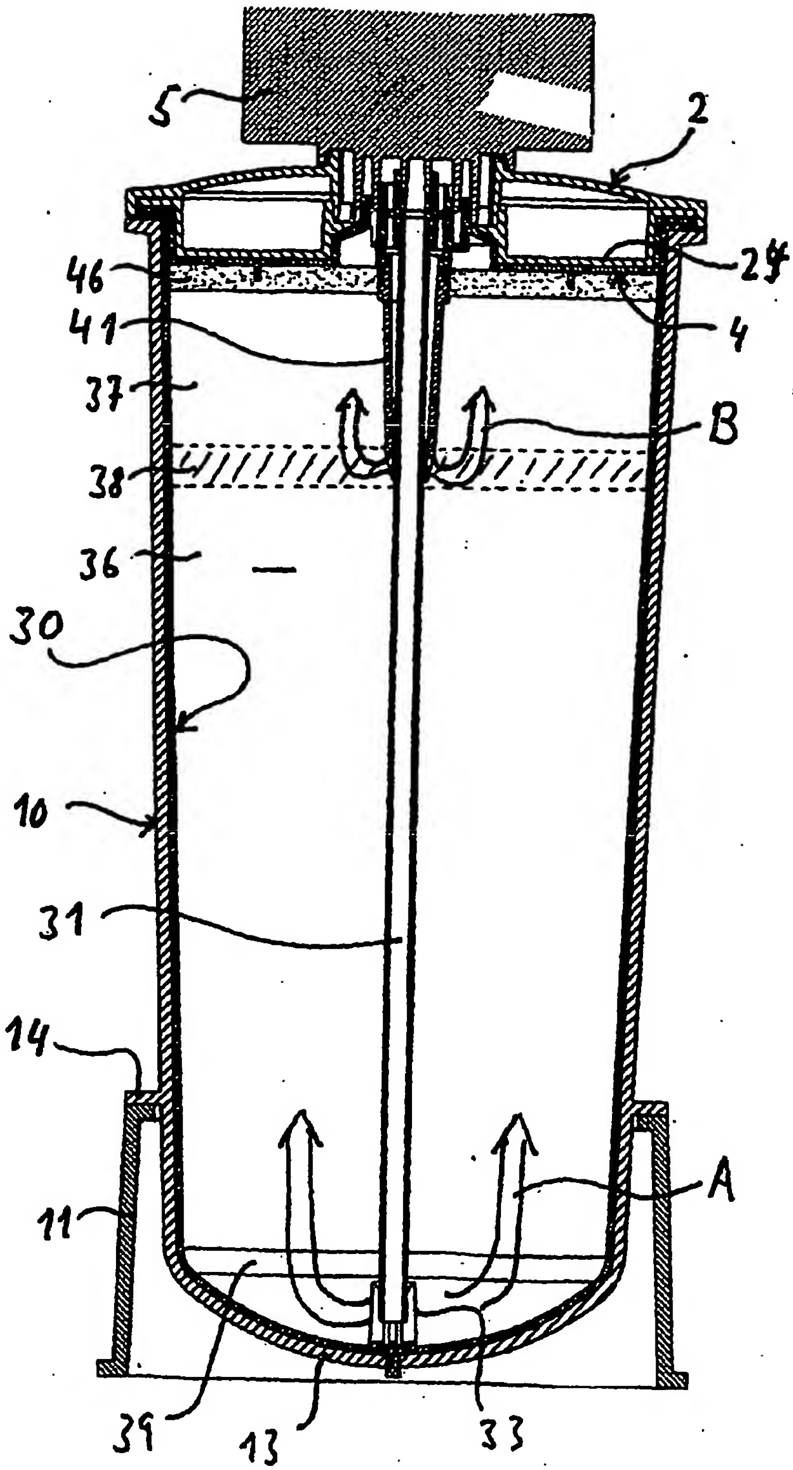

Fig. 1

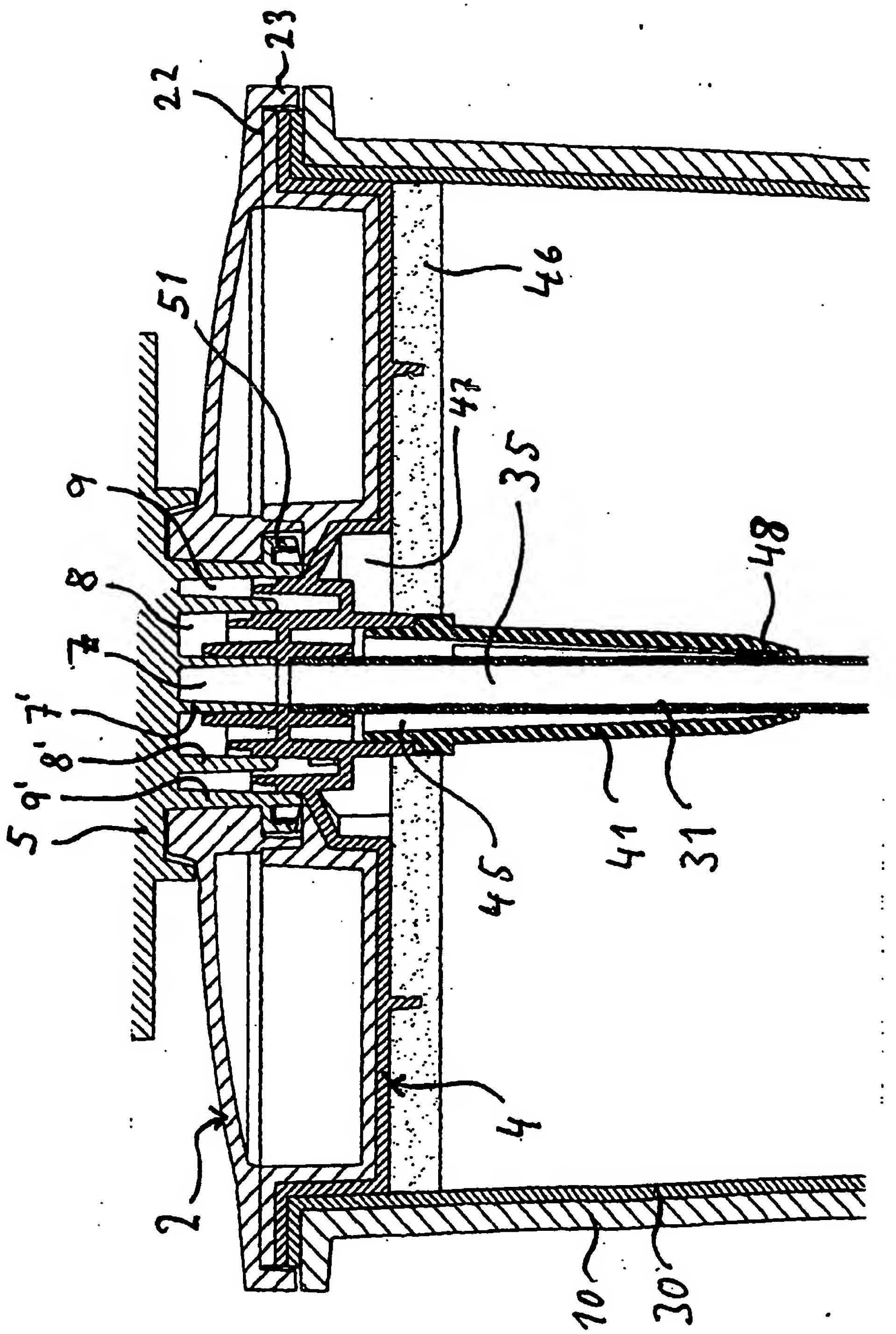

Fig. 2

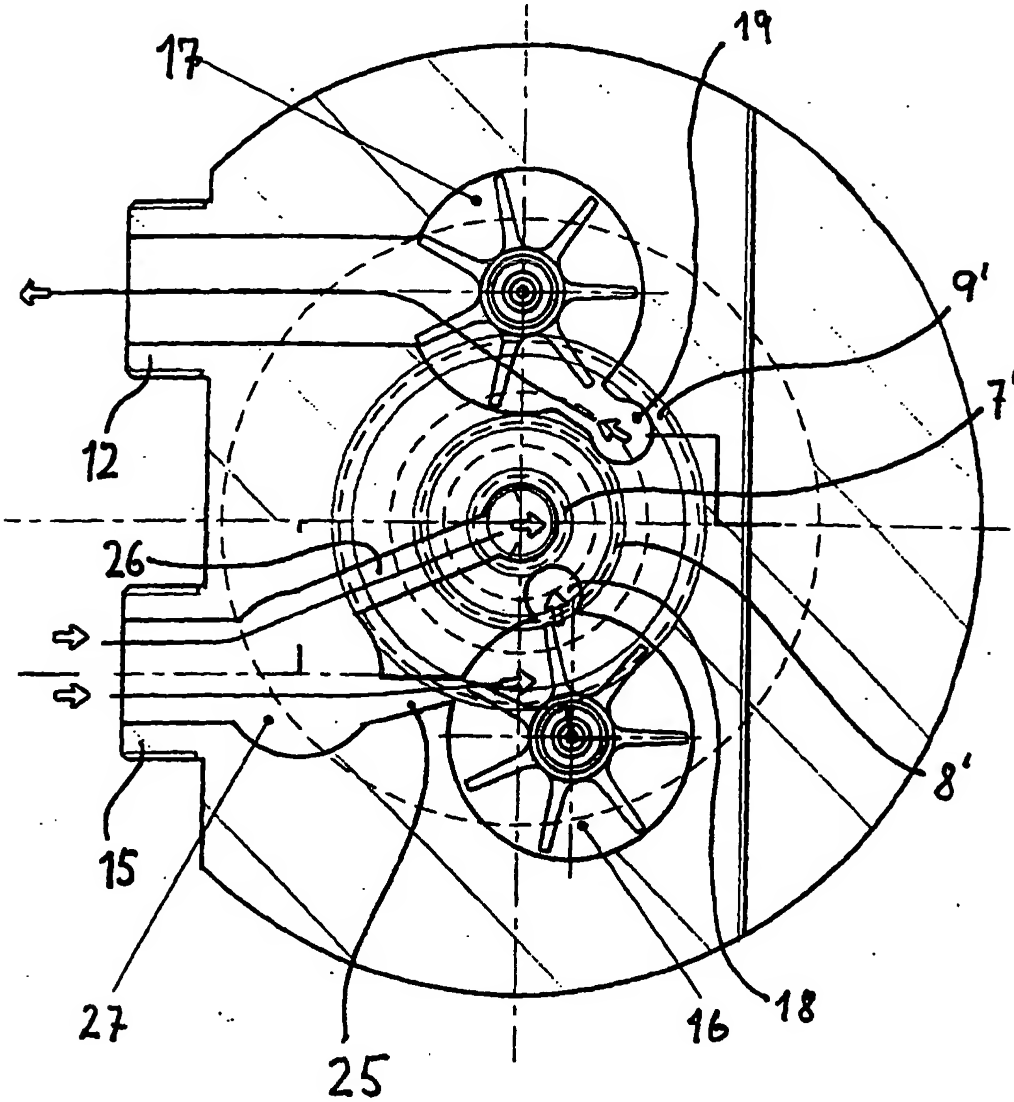

Fig. 3

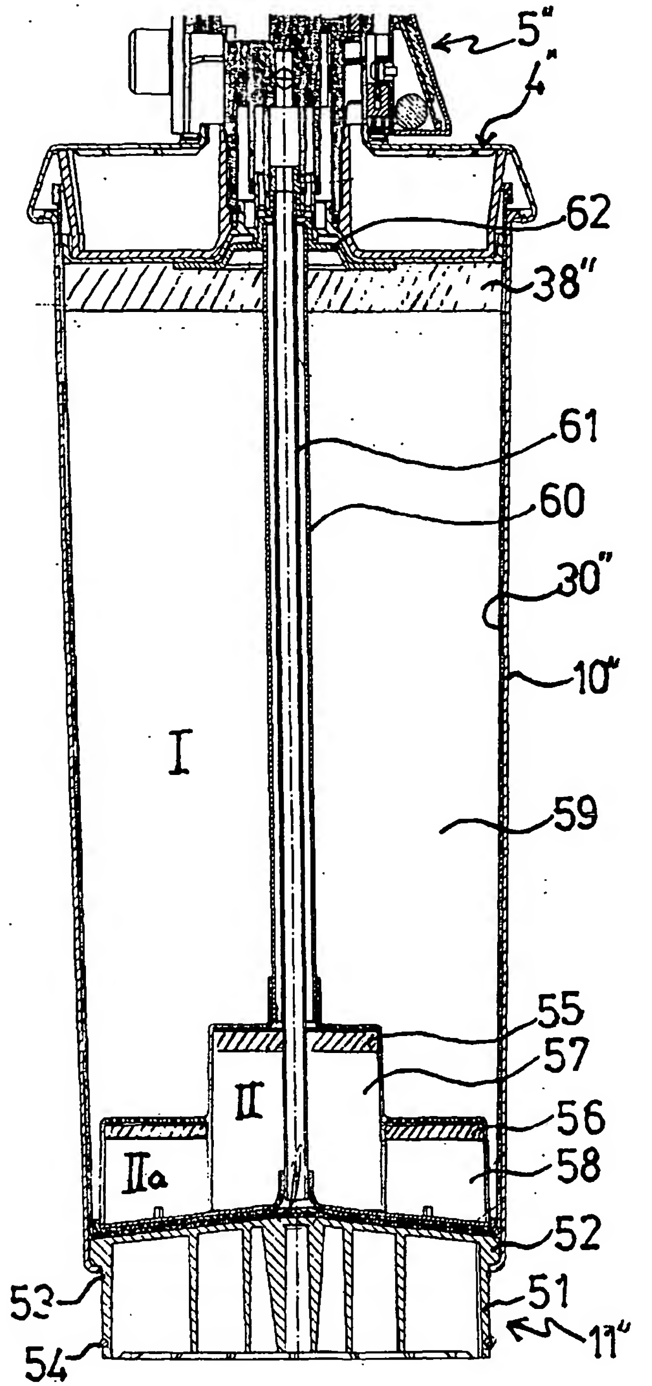

Fig. 4